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# Exploring astronomy and astrology under Delhi sultans: Knowledge, culture and practice

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**Abstract**
This study examines the evolution of astronomy under the Delhi Sultans through cross-cultural exchanges, translations, and intellectual patronage, highlighting the synthesis of Greco-Arabic, Persian, and Indian traditions within a uniquely Indo-Islamic intellectual context. Drawing on a range of sources, textual, biographical, and instrumental, it examines how translation, patronage, and cultural interaction facilitated the assimilation and transformation of astronomical knowledge. Figures such as Amir Khusrau, Thakkura Pherū, Mahendra Suri, and Sultan Firuz Shah Tughlaq exemplify the interweaving of literary, scientific, and religious traditions. By analysing the zīj literature, astrolabe treatises, and cross-cultural translations, the paper argues that the Delhi Sultanate was not a mere conduit but an active site of innovation, adaptation, and intellectual exchange in the history of astronomy in South Asia.

**Keywords** Astrologer · Astronomical literature · Astronomical tables · Horoscopes · Jyotisāra · zīj Literature

## 1 Introduction: the importance of astronomy in religion, science, and politics

Astronomy held immense practical, religious, and intellectual significance in the medieval Islamic and Indian worlds. In Islam, accurate knowledge of celestial movements was essential for determining the timing of prayers, the direction of the *qibla*, the lunar calendar, and the observance of religious festivals, while in the Indian tradition, astronomy (*jyotiṣa*) was deeply embedded in temple rituals, timekeeping, and statecraft, blending seamlessly with astrology. The Delhi Sultanate (1206–1526 CE) arose during a period marked by intense scientific transmission and cultural exchange. As the Sultans consolidated their authority over northern India, they fostered an environment conducive to the reception and adaptation of three different scientific traditions, i.e., Greco-Arabic, Persian, and Indian. The influx of scholars from Central Asia, many of whom were displaced by the Mongol invasions, played a pivotal role in introducing Arabic and Persian astronomical texts. Instruments such as astrolabes and methodologies were subsequently localised within the Indian context. The result was the emergence of a distinctive Indo-Islamic astronomical culture that merged practical science with philosophical and cosmological inquiry. This paper explores the intellectual history of astronomy under the Delhi Sultans by tracing the chronological development of astronomical knowledge, examining the mechanisms of cultural transmission, analyzing key texts and figures, and assessing the impact of language and translation. It also examines how the Sultanate navigated the interconnected realms of astronomy and astrology, which were shaped by Islamic thought, Persian influences, and Indian traditions. In doing so, it aims to provide a comprehensive understanding of how the Delhi Sultans contributed to the evolution of astronomical and astrological practices and influenced the development of scientific thought and intellectual culture during the Delhi Sultanate period.

The study of astronomy and related sciences in the Indo-Islamic world has attracted considerable scholarly attention, though the Delhi Sultanate period remains comparatively underexplored. Among the pioneering contributions, David Pingree's "*Census of the Exact Sciences in Sanskrit*" (Five vols., 1970–1994) and his essays on Indian astronomy and astrology provide foundational insights into the transmission of Greco-Arabic and Indian astronomical traditions (1976). Michio Yano has similarly examined Indian interpretations of Islamic astronomical instruments and their adaptation into

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Sanskrit treatises Yano, 1996). The work of S. R. Sarma, particularly his studies on the astrolabe and mathematical instruments, has illuminated the technical sophistication and syncretic development of Indo-Islamic astronomy. His essay "*The Archaic and the Exotic: Studies in the History of Indian Astronomical Instruments*" is of particular relevance (Sarma, 2008). S. A. Rahman's "*The Astrolabe*" also offers a detailed account of the evolution of astronomical instrumentation and its cultural contexts (Rahman, 1999). D. Chattopadhyaya, in his "*Studies in the History of Science in India*", brings together essays that touch upon medieval Indian astronomy, though the focus is often weighted toward the Sanskritic tradition or the Mughal period (Chattopadhyaya, Vol. 2, 1982). More recently, Razaullah Ansari has made vital contributions to the study of Islamic and Indo-Islamic science. His edited volume "*History of Science in Medieval India*" (Ansari, 2001), as well as articles on *zīj*[1] literature and observatory traditions, highlight the Islamic contributions to Indian astronomy and argue for an integrated historical approach that foregrounds both textual and instrumental evidence.[2]

Despite these important interventions, the specific role of the Delhi Sultanate, as a phase of confluence and transformation of astronomical knowledge, has not received sustained scholarly attention. Most studies either leap from the early medieval Indian texts to Mughal advancements or treat Indo-Islamic science in general terms without attending to the distinctive cultural, political, and linguistic frameworks of the Sultanate period. This paper attempts to fill this gap by exploring the ways in which the Delhi Sultans and their intellectual circles shaped, sustained, and reinterpreted astronomical knowledge through processes of translation, textual composition, royal patronage, and technological innovation.

## 2 Chronological advent of astronomy

### 2.1 Early Indian traditions (Pre-Sultanate)

Before the advent of Islamic and Persian influences during the Delhi Sultanate, Indian astronomy was already deeply rooted in traditions that blended inherited foreign models with indigenous mathematical ingenuity. Mathematical astronomy, along with celestial divination and astrology, was first introduced to India from Mesopotamian and Greek sources, beginning as early as the fifth or fourth century CE with Lagadha's *Vedāṅga Jyotiṣa*.[3] Over time, Indian scholars absorbed and transformed various Greek systems, including epicyclic and eccentric models, into unique *siddhāntic* traditions. However, this early Indian approach to astronomy was characterised more by theoretical elaboration and mathematical creativity than by systematic observation. Tools like the gnomon were used, but accurate star catalogues and sophisticated instruments such as the astrolabe only appeared later. Despite the lack of observational precision, early Indian astronomers made substantial contributions in trigonometry, approximation methods, and numerical analysis, which later influenced Islamic and European astronomy through translated works. This foundational period established the intellectual backdrop against which later astronomical developments under the Delhi Sultans would unfold (Pingree, 1978, pp. 361–364). Later on, the classical *Siddhānta* texts such as *Āryabhaṭīya* by Āryabhaṭa (499 CE), *Brahmasphuṭasiddhānta* by Brahmagupta (628 CE) and *Pañca-siddhāntikā* by Varāhamihira (sixth century) were compiled in India. The strong mathematical orientation of Indian astronomy and its use of planetary models and eclipse predictions show that Indian astronomers focused more on calculations than on direct observations, using ideas from other cultures but adapting them in their own way to create complex systems for calendars, rituals, and astrology.

### 2.2 Greco-Arabic influence and Islamic astronomy (eighth-twelfth century)

The performance of key religious duties in Islam, such as prayer, fasting, and pilgrimage, relies heavily on precise astronomical timekeeping, geographical positioning, and lunar crescent observation. These religious imperatives spurred a significant engagement with astronomy and related sciences, initiating a major transmission of knowledge during the expansion of Islam from the eighth century onward. As Muslims encountered the intellectual traditions of Babylon, India, Iran, and Greece, a vibrant translation movement

[1] A *zīj* (astronomical handbook) is a compilation of astronomical tables used to calculate the positions of celestial bodies, such as the Sun, Moon, planets, and stars, at different times. *Zījāt* (Arabic/pl. of *zij*) typically include: Chronological tables (calendars, planetary positions); Ephemerides (daily positions of heavenly bodies); Trigonometric tables for calculations; Instructions on calculating eclipses, ascendants, and prayer times. In the Delhi Sultanate, *zīj* literature such as *Zīj-i-Nāsiri* served both scientific and astrological purposes. Astronomers used these handbooks to create horoscopes, predict eclipses, and determine auspicious timings. These texts reflect the blend of Indian astronomical models with Greco-Arabic computational systems.

[2] Other works by S. M. Razaullah Ansari are: 'Zij Literature in India and its Impact,' in *Proceedings of the International Astronomical Union Symposium*, No. 260, 2009; 'Astronomy in Medieval India', *Encyclopedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, Third Edition, Dordrecht, 2016.

[3] The earliest known Indian astronomical text (c. 1200 BCE), focused on timekeeping and ritual calendars.

emerged, reaching its zenith under the Umayyads and especially the Abbasids. During the Abbasid Caliphate, particularly under Caliphs al-Mansur and al-Ma'mun in Baghdad, Greek, Persian, and Indian scientific texts were systematically translated into Arabic, laying the foundation for Islamic astronomy (Ansari, 2016, p. 717). Works such as Ptolemy's *Almagest* and Indian treatises like *Brahmasphuṭasiddhānta* and *Sūrya Siddhānta* were absorbed and further developed. Islamic scholars not only preserved but also refined this knowledge, al-Battani improved the measurement of the solar year and planetary motions; al-Sufi catalogued stars and constellations by blending Greek models with Arabic traditions; al-Birunī provided critical comparative studies of Indian and Greek systems; and Nasir al-Din al-Tusi, building on this rich heritage in the thirteenth century, proposed the Tusi couple, a mathematical model that would later influence heliocentric theories in Europe. This synthesis of diverse scientific traditions transformed Islamic astronomy into a powerful intellectual current that played a pivotal role in the eventual transmission of classical astronomy to medieval Europe (Chander, 2015, pp. 103–106).

### 2.3 Arrival of Islamic astronomy in India (twelfth-thirteenth century)

The Mongol conquests of Central Asia and Persia in the thirteenth century triggered a wave of migration to the Delhi Sultanate, bringing with it a significant influx of scholars, scientists, and intellectuals seeking refuge. Among the sciences they carried were astronomy and astrology, along with new mechanical inventions, scientific instruments, and advanced scientific concepts. The Delhi Sultans, known for their intellectual curiosity and keen interest in knowledge, extended generous patronage to these immigrants, fostering a vibrant intellectual environment. This period marked the arrival and assimilation of Islamic astronomy in India, facilitated by trade, conquest, and migration. The Sultans actively supported the translation and study of scientific texts, the use of astronomical instruments, especially astrolabes, and the dissemination of *zīj* (astronomical-mathematical table and handbook) literature, which detailed astronomical tables. The combination of foreign immigration and state patronage created fertile ground for the flourishing of Greco-Arabic, Islamic, and Indian astronomical traditions within the Delhi Sultanate. This assemblage of cultures and sciences left a lasting imprint on the scientific thought, educational practices, and intellectual traditions of the Indian subcontinent during the medieval period.

The focus of Islamic astronomy was on observational astronomy with the establishment of observatories for practical use (Ansari, 2016, p. 718). There, in these observatories, *zijāt* (pl. of *zij* in Arabic) were compiled for determining the position of the Sun, Moon, various planets, and they often include a catalogue of stars. It marked a major development. These *zijāt* were used to calculate the positions of the Sun, Moon, and other planets. Some *zījāt* also feature a geographical gazetteer and were used to predict solar and lunar eclipses. Essentially, *zījāt* served as tools for observational astronomy, supporting the core functions of an astronomical observatory. While early Islamic *zījāt* were written in Arabic, later works were often compiled in Persian, reflecting the evolving scholarly language of the time. This knowledge, enriched by the study of *zījāt*, was significantly advanced, especially in observational astronomy.

Although astrology clashed with Islamic teachings and was condemned as blasphemous by orthodox scholars (*ulema*), it was considerably popular and thrived under the patronage of the ruling classes and aristocracy during the Delhi Sultanate period. The study of celestial bodies was not just a scientific pursuit but was closely linked to religious beliefs, political decision-making, and personal destiny, thus influencing daily life across the Sultanate. Early scholars from Khurasan and Central Asia who migrated to India did not seem skeptical of the influence of stars on earthly affairs. Astronomers, often reliant on astrology for their livelihood, prepared horoscopes and astrological tables. According to Afif, astronomy was one of the fourteen sciences recognised by scholars (Afif, 1891, p. 298). However, its study was prohibited by the Prophet of Islam and was similarly disapproved of by orthodox scholars or *ulema*. Despite this, certain aspects of astronomy were considered permissible, such as understanding the rules governing the sun's shadow, the specific degree determining the position of the sun in a specific zodiac sign during a given month, calculating the duration of short and long nights, and identifying the transition of night into day (Siddiqui, 1993, p. 140; 2009, p. 125). Afif's statement reflects his defence of astronomy and astrology, countering the opposition of Islamic orthodoxy, which rejected even the intellectual pursuit of these sciences. Afif was not alone in support of these sciences (Afif, 1891, p. 258); Amir Khusrau also advocated for astronomy, viewing its practice as far from blasphemous (Khusrau, 2007, p. 188). Similarly, Minhaj Siraj Juzjani, a rationalist theologian, remained uninfluenced by orthodox objections and regarded the study of astronomy as a valuable cultural pursuit (Juzjani, 1864, pp. 331–332).

The interest and patronage the Delhi Sultans extended to astronomers and astrologers reflected a shared cultural tradition that included Hindu and Muslim scholars. Following longstanding Indian customs, the Turkish Sultans and their ruling elites showed a keen interest in astrology. Hasan Nizami, who migrated from Nishapur to Delhi during Sultan Qutbuddin Aibak's reign (1206–1210 CE), expressed a firm belief in the zodiac, the seven planets, and constellations in his historical work, *Tāj-al-Mā'athir* (2008). Sadiduddin Muhammad Awfi (1974, pp. 401–402), meanwhile, refers to

Nizamul-Mulk Junaidi, the *wazir* of Sultan Iltutmish, as a *Sāhib-i-Qirān*, a title given to one born under the conjunction of two auspicious stars. When Sultan Iltutmish returned from Banian, having fallen seriously ill, the timing of his entry into Delhi was determined through consultation with astrologers (Juzjani, 1864, p. 176). Ibn Battuta also notes that the astrologers, well-versed in the science of the stars, predicted to Sultan Iltutmish that one of his slaves would usurp the Sultanate from the hands of his sons (Ibn Battuta, Vol. III, 1993, p. 634). These references highlight their belief in the influence of celestial bodies on human affairs.

Furthermore, Isami's reference concerning Sultan Ghiyasuddin Balban's military expedition to suppress the rebellion of Tughril in Lakhnauti (1271–72 CE) presents a compelling intersection of political authority, astronomy, astrology, and gendered intellectual participation in the Delhi Sultanate period. Amidst the narrative of military confrontation, a significant yet often overlooked detail emerges regarding the active involvement of Tughril's wife, who is described as possessing considerable astrological acumen. She is credited with forecasting the condition of night and day. According to Isami, she predicted an ominous shift in her husband's fortune based on celestial observations, advising him that if he escaped from the sword that particular day, he would have enjoyed a long life in this world. This forecast, grounded in her reading of the stars, not only influenced Tughril's immediate strategic considerations but also reflects the degree to which astrological knowledge was regarded as a legitimate and consequential form of political counsel during the Sultanate. Tughril had many times verified her knowledge of astrology, but also took precautions as directed by the forecast (Isami, 1948, pp. 168–169).

### 2.4 Amir Khusrau and the literati-scientist model

During the early Sultanate period, the scribe class was often well-versed in the mathematical sciences, including astronomy, as reflected in an ode by Amir Khusrau dedicated to his teacher, Shahab Mehmara (Khusrau, 1918, pp. 164–167). Khusrau himself possessed a deep understanding of astronomy, particularly the science of fixed stars, and even composed a poem on the twenty-eight lunar mansions (*al-Manzil*). He was influenced by earlier figures like al-Bīrūnī, and is said to have expressed views that the Earth moves around the Sun. He explained that this movement is tied to the passage of time, giving rise to day and night, and the seasons of spring and autumn. These changes, he noted, are the foundation of life and a source of comfort for all living beings (Khusrau, 1918, p. 5). He expressed a view consistent with heliocentrism, metaphorically likening the Earth's movement around the Sun to the orbit of subjects around a political authority in *Ijāz-i-Khusravī* (Khusrau, 1976, pp. 236–318). His fascination with astronomy also led him to explore Hindu scientific achievements, praising their knowledge and expertise in physics, mathematics, astronomy, and divination (Siddiqui, 2009, p. 124). He also mentions that he gained some understanding of the intricacies of their sciences (Khusrau, 1949, pp. 162–163). As a result, he could draw horoscopes due to his knowledge of the subjects. Khusrau further exemplifies the integration of literary and scientific culture in the Delhi Sultanate. Although not a professional astronomer, his writings consistently reflect sophisticated astronomical and astrological understanding (Khusrau, 1949, pp. 224–226). His poetry can be classified into three broad categories in which astrological themes are commonly used:

**Horoscopic descriptions**: He frequently constructed detailed horoscopes to mark significant events. In *Qirān-us-Sā'dain*, he interpreted the planetary positions at the time of the meeting between Kaiqubad and Bughra Khan at Lakhnauti. He had enunciated the horoscope of that moment (Khusrau, 1918, pp. 167–168). In *Nūh Sipihr*, he described the planetary positions on the occasion of the coronation of Sultan Qutbuddin Mubarak at Delhi. The exact time of coronation was selected and predetermined astrologically (Khusrau, 1949, pp. 49–52). He also described the planetary positions on the occasion of the birth of Prince Muhammad at Delhi (Khusrau, 1949, pp. 320–327). Similarly, he noted the conjunction of planets during the coronation of Sultan Ghiyasuddin Tughlaq (Khusrau, 1933, pp. 143–145). In his astrological poetry, complete horoscopes have been interpreted to predict good or bad influences of a birth or an event in a figurative manner.

**Celestial events and poetry**: In this category, Khusrau discussed the attractiveness of a function based on the position of planets, lunar mansions, and constellations. He used planetary symbolism to enhance the celebratory tone of royal functions. In *Nūh Sipihr*, he personifies zodiac signs and planets, portraying them as rejoicing during princely births. He describes the ecstasy of the twelve zodiac signs and the happiness and enthusiasm expressed by the seven planets to participate in the rejoicings held at Delhi on the occasion of the birth of a Prince (Khusrau, 1949, pp. 238–330, 330–331). Other mentions of such references are also found in his literature (Khusrau, 1916, pp. 11, 12; Khusrau, 1918, pp. 164–167; Khusrau, 1933, pp. 80, 81, 103; Khusrau, 1954, p. 9).

**Symbolic usage and courtly metaphor**: In this category, he used astrological terms and symbolism to denote figures of speech. His works contain couplets defining astrological terms and symbolism. For instance, in *Qirān-us-Sa'dain*, Khusrau employed astrological symbolism to frame courtly scenes. He described the wonderful performance of the dancers of the court of Sultan Kaiqubad, displayed in the gathering of those stars (courtiers). Even *Venus* was enchanted by the performance of the dancers of the court

(Khusrau, 1918, p. 23).[4] These metaphors not only display his technical knowledge but also suggest the cultural prestige of astrology in elite settings.

References in Khusrau's work (Khusrau, 1917, p. 62) to instruments like the astrolabe indicate that he possessed technical knowledge of the instrument, and such tools were familiar in elite intellectual circles of Delhi.[5] His mention of the tablet of clay for the astronomers to determine all events and the skilled astrologers of his time, including Banda Sharaf and Najm, who claimed his expertise and attainment in astrology so highly further illustrates the vibrant astrological culture that permeated both court and scholarship (Khusrau, 2007, Vol. IV, pp. 123, 144, 221).

### 2.5 Integration and patronage under Delhi sultans (thirteenth-fourteenth century)

Barani offers valuable insights into the intellectual environment of Delhi during the thirteenth and fourteenth centuries and sheds light on the collaboration between Hindu and Muslim astronomers of the period. He emphasizes the active engagement in observation and experimentation at the time. He further draws attention to the support extended by the Delhi Sultans to men of remarkable learning and skill, which encouraged the growth of various disciplines, both theoretical and practical. While addressing a range of disciplines, his remarks on the progress of astronomy and the contributions of astronomers stand out. He notes that Maulana Hamid-ud Din Mutriz, with his profound expertise in medicine (*tib*) and astronomy, could be compared to the renowned Greek scientists of antiquity (Barani, 2005, p. 112).

During the reign of Sultan Alauddin Khalji (1296–1316 CE), there was a remarkable flourishing of learning and culture. Under him, the Delhi Sultanate's growing reputation attracted scientists and intellectuals from various countries, who made Delhi their home. This influx of talent elevated the status of Delhi, surpassing Baghdad and Cairo as a center of culture and rivaling Constantinople, which was then the hub of Greek sciences and philosophy. Barani also emphasizes the prominence of expert astronomers during this period, who gained widespread acclaim for their skill in calculating astronomical tables. Astronomy and astrology were so deeply ingrained in the culture of Delhi that every neighborhood reportedly had an astronomer. These scholars enjoyed significant patronage, receiving gifts, monetary rewards, villages, and stipends from Sultan Alauddin Khalji, the nobles and other elites, including influential citizens of the city. Barani mentions that many expert astronomers gained fame because of their knowledge of calculating astronomical tables. Even the royal ladies from the *harem* of Sultan Alauddin Khalji lavishly awarded astrologers for drawing the horoscopes of the newly born princes. Furthermore, Hindu and Muslim astronomers and astrologers were held in great esteem, reflecting their shared prominence in society. They were awarded both in cash and kind, for their expertise and experience, by the Sultans, Maliks, Amirs, Khans, Khwajas and other notables. Thus, astrologers were found in every quarter (*mohalla*) of the capital city of Delhi. They brought four to five hundred *taqweem* and two to three hundred astronomical tables/horoscopes before the nobles and other dignitaries, for which they were rewarded. However, Barani (2005, pp. 362–365) notes that the elites of Delhi could not start any work or undertake any project, and marriage could not be arranged without first consulting the astronomers and astrologers. Thus, they earned their livelihood by practicing astrology. This widespread reliance on astrological advice reflects how deeply astrology had become enmeshed with astronomy, serving as a unifying intellectual interest for both Hindu and Muslim elites in the Delhi Sultanate period.

Amir Khusrau (1916, pp. 154–169) informs that the astrologers were consulted in the marriage of Prince Khizr Khan and Dewal Rani and fixed the auspicious time for the marriage procession, *nikāh,* and *rukhsati*. Likewise, when Isami records the marriage of Prince Shadi Khan with the daughter of Malik Alp Khan speaks about the expert astrologers who scrutinized the horoscope and found out the most auspicious moment for the conjunction of the moon and Jupiter. Thus, blessings came from all sides as the hour of junction arrived (Isami, 1948, p. 324). It is recorded that Sultan Alauddin Khalji ordered the astrologers (*munajjiman*) who were in charge of preparing the *almanac* and those who calculated the events by the aspect of the stars to specify an auspicious date for the marriage celebration of the prince. In conformity with the royal mandate, the astrologers ascertained a day of good omen in accordance with the computation of the calendar and the aspect of the stars (Sirhindi, 1931, p. 79).

The sciences of astronomy and astrology reached a peak point during the reign of Sultan Alauddin Khalji. This period saw a growing demand for astrologers as their expertise became highly valued. Barani (2005, pp. 363–364) mentions that some astronomers and astrologers achieved remarkable mastery in their fields, enabling them to construct sophisticated astronomical observatories. He mentions Banyanina, Fathian, Salahian, Maulana Sharafuddin Mutarraz, and Farid Rukn Ajaib as the expert astrologers of the period, who, because of their expertise in the subjects, received villages

[4] For references denoting symbolism in the poetry of Amir Khusrau, See *Qirān-us-Sadain*, pp. 144, 145, 231, 234; Amir Khusrau, *Nuh Sipihr*, pp. 120, 135; Amir Khusrau, *Duwal Rani Khizr Khan*, p. 18, 115, 116, 183; Amir Khusrau, *Tughlaqnāma*, pp. 81, 122, 135; Amir Khusrau, *Miftah-ul-Futuh*, p. 11.

[5] "With the accurate yellowish astrolabe, the astrologers buried themselves in knowing the auspicious moment."

and stipends from the Sultan (Sen and Shukla, 2000, p. 32). In his writings, Amir Khusrau highlights the intellectual pursuits of Indian scholars, observing that Brahmins possessed considerable expertise in Aristotelian sciences such as physics, mathematics, astrology, and astronomy (Khusrau, 1949, pp. 162, 167–168). Such was the prominence of the subject during this period that it attracted foreign scholars to India in pursuit of knowledge and expertise. Amir Khusrau records that a foreign scholar named Bu Muashar came specifically to study it. He reportedly spent a decade in Banaras[6] studying *ilm-i-kalam*, during which he also gained exceptional expertise in astrology. His knowledge in the field was regarded as unparalleled (Khusrau, 1949, p. 167).

Ibn Battuta (1993, Vol. III, p. 654) mentions that astrologers had declared that Sultan Ghiyasuddin Tughlaq would never again enter the city of Delhi after the expedition of Lakhnauti; he used threatening language towards them. Isami also mentioned that Ulugh Khan (later Sultan Muhammad bin Tughlaq) consulted Ubaid, the astrologer, who was skilful in the arts of *ramal* (geomancy) and *nujūm* (astronomy), regarding his Telingana expedition and to forecast the date of the fall of the fort. Ubaid confidently predicted the victory within a week, accurately specifying the exact day and time. He was so assured of his calculations that he even declared his willingness to face death if his prediction proved wrong (Isami, 1948, pp. 393, 395).

### 2.6 Firuz Shah Tughlaq's contribution to astronomy

Furthermore, *Sīrat-i-Firūz Shahi* (Anonymous, 1999a, p. 415) highlights Sultan Firuz Shah's knowledge of telling the time and directions of the prayers. It refers to the fact that Sultan Firuz, with his wisdom and perfect skill, could calculate and draw forth the 36th part of the circumference of the circle, indicating the days that cast their shades on the people with paces and minutes, based on the different degrees of units of the measure for angles or arcs of the sun and the zodiacal signs. After getting the specific sign of the zodiac and the number of degrees between their sides and the position occupied by the sun, they got to know the time, in terms of places and minutes in the table representing the zodiacal signs and degrees or measure of the angle. All this was done at the instance of Sultan Firuz and was inscribed to facilitate the fulfilment of the needs of the men of rectitude and devotion and enable them to obtain their wishes and gain happiness and prosperity.

Interestingly, Firuz Shah Tughlaq prepared a *jadwal* (astronomical chart/calendar) to know the direction of the *Qibla*. *Sīrat* explains that for determining the direction in the daytime, if the sun is towards the north, that is, from the zodiacal sign of Aries to that of Virgo, one should keep oneself on the right side, that is, one should stand so as to have the sun on the right side. If the sun was towards the south that is between the signs of Libra and Pisces, one should keep himself on the felt side; and if it is night time, one should keep the sign of crab on the right side and of Capricorn on the left side; and it was in this way one could know the direction of *Qibla* (Anonymous, 1999a, p. 425).

### 2.7 Patronage under Delhi sultans (fourteenth-fifteenth century)

There is limited information about the Saiyyid Sultans and their noble's interest in the sciences of astronomy and astrology. Yahya mentions that Sultan Mubarak entered the capital city according to the auspicious time calculated by the astronomers (Sirhindi, 1931, pp. 204, 205, 206, 211, 227). While no astronomical works from the Lodi period have surfaced, evidence suggests that the Sultans and their nobles patronized astronomers and astrologers, much like they did for other scholars and learned individuals. All three Lodi Sultans had astronomers at their courts whom they consulted on important occasions (Nizamuddin, 1875, p. 327; Yadgar, 1939, pp. 19, 24). Nimatallah records that nobles and the grandees of the state elevated Ibrahim Lodi to the throne after consultation with the astrologers for an auspicious hour for the coronation (Nimatallah, 1958, p. 152).

### 2.8 The role of Jain and Hindu scholars

The intellectual atmosphere of the Delhi Sultanate was deeply indebted to the pre-existing Indian astronomical traditions, particularly the *Vedāṅga Jyotiṣa* and the classical *Siddhāntas*. These foundational texts provided the framework for observational, calendrical, and mathematical astronomy, which continued to evolve during the Sultanate period. Figures like Thakkura Pherū and Mahendra Sūri demonstrate the engagement with Islamic astronomy. Thakkura Pherū, the assayer in the royal mint, during the period of Alauddin Khalji, composed *Jyotisāra*, a treatise written in simple Prakrit. His objective was to popularise astronomical knowledge among the masses. He consciously acknowledged earlier Indian authorities, such as Varāhamihira and Lalla, and attempted to bridge traditional *siddhāntic* astronomy with the needs of contemporary society (Pherū, 1984, pp. 7–8; Sarma, 1986, p. 67). Another of his works, *Ganitasārakaumudi*, further exemplified the practical application of astronomical and mathematical knowledge in commercial and daily contexts, particularly among the Jaina

[6] For more on Banaras during the Delhi Sultanate period, see my article, 'Growth of Authority over Conquered Region: Politico-cultural Study of Banaras during Sultanate Period, ***Journal of the Pakistan Historical Society, Karachi***, Vol. 67, Oct–Dec 2019.

mercantile communities (Pherū, 2009). Equally notable was Mahendra Sūri, a Jain scholar from Gujarat who flourished under the patronage of Sultan Firuz Shah Tughlaq. In 1370 CE, he composed *Yantrarāja*, the first known Sanskrit treatise on the construction and use of the Islamic astrolabe. This text represents a unique synthesis: while drawing from Arabic sources, Mahendra employed Sanskrit verse to encode technical knowledge, adapting Islamic geometric models into the Indian scholarly tradition. His work, and its later commentary by Malayendu Suri, exemplifies the successful integration of indigenous and imported sciences (Sarma, 2000, pp. 8, 21–22).

## 3 Cultural transmission and synthesis

### 3.1 Greco-Arabic knowledge via Central Asian migration

The Mongol conquests of Central Asia in the thirteenth century caused a mass migration of scholars, scientists, artisans, and bureaucrats to safer regions, including the Delhi Sultanate. These migrants brought with them the intellectual legacies of Greco-Arabic science, especially the corpus of Greco-Arabic astronomical texts, instruments like the astrolabe, and observational methods developed in Baghdad, Maragha, and Samarkand into the Indo-Islamic scholarly milieu.

### 3.2 Blending of Greco-Islamic and Indian knowledge

The most remarkable feature of this period was a dynamic synthesis of intellectual legacies from distinct traditions: Greco-Islamic and Indian astronomical traditions. This convergence was not a passive transfer of knowledge but a dynamic cultural process. Texts were translated from Sanskrit into Persian (e.g. *Tarjumāh-i-Barāhī*), and vice versa, creating bilingual intellectual zones. Thakkura Pherū's works in Prakrit introduced Indian audiences to mathematical and calendrical techniques that incorporated Islamic principles.[7] Meanwhile, Mahendra Sūri's *Yantrarāja* adapted the Islamic astrolabe to the Indian context, merging Arabic geometrical astronomy with Sanskritic cosmology (Sarma, 2000, pp. 8, 21–22). This synthesis is also evident in the practical application of blended knowledge systems. Instruments like the astrolabe**,** originally Arabic in form, were refined by Indian artisans under the Sultanate. The creation of instruments like the *Tas Ghariyāl* (Gong or water clock) (Afif, 1891, pp. 254–260) and the *Usturlab-i-Firuz Shāhī* (Anonymous, 1999a, pp. 402–404) served as an example of Greco-Islamic instrumentation that was innovatively reinterpreted to suit both Islamic ritual needs and Indian environmental conditions. The confluence of these traditions also had profound implications for religious life, astrology, architecture, and daily administration. The use of astronomical calculations for prayer times, calendrical conversions, and horoscopic predictions signified not just the co-existence of different traditions but their functional integration into statecraft and public life. Thus, the Delhi Sultanate emerged as a crucible of cultural fusion, where the migration of knowledge was met with robust patronage and transformed through sustained interaction with the local indigenous traditions.

As a result, Delhi became a recipient of this intellectual influx. A prime example of this integration is the *Zīj-i-Nāsiri* compiled by immigrant scholar Mahmud ibn Umar and dedicated to his patron, Sultan Iltutmish. Composed between 1235 and 1245 CE, this text represents the earliest known astronomical table (*zīj*) written in India. Drawing upon Greco-Islamic authorities such as Hipparchus, Ptolemy, al-Battānī, al-Ṣūfī, and al-Bīrūnī, Mahmud ibn Umar synthesised centuries of astronomical theory into a text grounded in local observations from Delhi. This work not only predated Naṣīr al-Dīn Ṭūsī's *Zīj-i-Ilkhānī* but also marked the beginning of Indo-Persian scientific writing on astronomy (Storey, 1958, Vol. 2, Pt. 1, p. 52). This work facilitated the adaptation of Islamic astronomical knowledge to the Indian context, including setting observational parameters using Delhi as a base meridian.[8]

The transmission of Greco-Arabic knowledge extended beyond texts. Translations of Sanskrit works into Persian, particularly under Firuz Shah Tughlaq, further reinforced this synthesis. Notable among these was the *Tarjumāh-i-Barāhī* (Rahman, 1982, p. 275), a Persian translation of Varāhamihira's *Bṛhatsaṃhitā,* and the *Dalāʾil-i-Fīrūz Shāhī* (Anonymous, 1999a, pp. 303–305), derived from Sanskrit manuscripts collected by Sultan Firuz Shah. These texts deal with planetary conjunctions, eclipses, and meteorological phenomena, revealing a shared epistemological framework across cultures.

[7] For details see *Jyotisara* and *Gaṇitasārakaumudi*.

[8] Mentioned by other scholars: A. Rahman, *Science and Technology in Medieval India: A Bibliography of Sources Materials in Sanskrit, Arabic and Persian*, New Delhi, 1982, p. 330; Sarma, 'Survey on Source Materials', pp. 20, 34; S. M. Razaullah Ansari, 'Survey of Zijes Written in the Subcontinent', *Indian Journal of History of Science*, Vol. 50, Part 4, 2015, p. 577.

## 4 Texts and scholars

The Delhi Sultanate period witnessed the production of a number of significant scientific texts that reflected the confluence of Indo-Islamic and indigenous Indian astronomical traditions. The works demonstrate the depth and diversity of intellectual activity in the realm of astronomy and astrology. These scholars and their works not only preserved earlier knowledge but also adapted and innovated within new socio-cultural and linguistic contexts.

### 4.1 Zīj-i-Nāsiri

The *Zīj-i-Nāsiri*, written by Mahmud bin Umar, is dedicated to the reigning Sultan Iltutmish and is considered the first *zij* (astronomical table) written in India (Storey, 1958, Vol. 2, Pt. 1, p. 52). This work was believed to be completed before 1265 CE when observations were made at the Maragha Observatory. These observations were later used to compile the renowned *Ilkhāni* Tables of Khwaja Nasiruddin Tusi. Storey observed that its unique manuscript was once housed in the Husayn Agha Nakhjawani Library in Tabriz (Storey, 1958, Vol. 2, Pt. 1, pp. 74–75; Ansari, 2015, pp. 577–578). Unfortunately, this work didn't survive, but its importance can be well understood because Abul Fazl mentioned it in his list of *zijāt* (Abul Fazl, 1871, p. 211, No. 72). However, a modern scholar, C. A. Storey, points to a unique manuscript copy of this *zij* in a private library of Tabrez owned by Husain Aba Nakhjawani (Storey, 1958, Vol. 2, Pt. 1, p. 52). A transcript of some part of this *zīj* was made and is reported in Mulla Firoz Library, Mumbai (Sen & Shukla, 2000, pp. 34–35). In one of his numerical examples, the date given is Thursday, 22 *Shā'bān* A.H. 641/February 4, 1244 CE, with the base meridian set in Delhi. Most of the author's examples fall within the period of 1235–1245 CE, during which Mahmud ibn Umar was compiling this *zīj*. This indicates that the first Indian *zīj* was completed well before Naṣir al-Dīn Tusi's *Zīj-i Ilkhānī*, compiled in 1271 CE (Ansari, 2015, p. 578). The author was also the first Indian scholar to write in Arabic or Persian on scientific subjects (Rahman, 1982, p. 330). In the introductory folios of his work, Ibn Umar al-Razi mentions his thirty years of studying earlier *zijāt* compiled by practical astronomers. He lists fifteen astronomers whose works he had studied, including notable figures such as Hipparchus, Ptolemy, al-Battani, al-Ṣufi, al-Biruni, al-Khazini, and al-Shirwani (Ansari, 2015, p. 578).

### 4.2 Thakkura Pherū and his works: *Jyotisāra* and *Gaṇitasārakaumudi*

The genre of practical handbooks also garnered attention, seemingly sparking an interest in the more theoretical *siddhānta* texts. For example, the Jain assayer in the royal mint at Delhi, Thakkura Pherū,[9] was a scientist of a versatile nature. His in-depth perception of astronomy and astrology sciences has been scientifically explained in his work *Jyotisāra*, written in 1315 CE. The value of *Jyotisāra* may well be ascertained by the acknowledgement of earlier Indian works on astronomy in his preface (Pherū, 1984, pp. 7–8; Sarma, 1986, p. 67). The motive of the composition of this work was to popularise the astronomical sciences among the masses since it was written in a simple Prakrit, a language of the general people.

Another work, *Ganitasārakaumudi* (2009), was also written by Thakkura Pherū. This Prakrit text serves as a compendium of basic astronomical knowledge. In his work, compiled in 1315 CE, Pherū cited the Hindu astronomical authorities Varāhamihira and Lalla, as well as both Jain and Hindu astrologers (Plofker, 2010, p. 4). He authored several texts in Prakrit covering gemmology, architecture, astronomy, assaying, and related subjects. Among these was a treatise on arithmetic and practical computation, *Gaṇitasārakaumudī* (Moonlight of the Essence of Mathematics). The basis of astronomy is mathematics. Thus, Thakkura Pherū was well-versed in mathematics. His work, *Gaṇitsārakaumudi*, is not dated; it must have been completed before 1318 CE. This work expands the scope of mathematics beyond the traditional framework of earlier Sanskrit texts. It incorporates a variety of topics from daily life where numbers play a significant role, thus making it innovative in applying arithmetic rules to practical areas. In *Gaṇitasārakaumudi*, Thakkura Pherū not only considered the theories of his predecessors but also integrated his own practical knowledge. He aimed to create a practical manual to benefit professionals such as bankers, traders, accountants, and masons. The value of this work lies largely in its supplementary materials, which offer a unique glimpse into the life of the Delhi-Haryana-Rajasthan region in the early fourteenth century, an insight not found in other mathematical texts. Practical advice for the business community, particularly the Jaina, is evident throughout, including mechanical shortcuts for commercial arithmetic, mathematical riddles, rules for converting dates between the Vikrama and Hijri calendars, and methods for classifying and constructing magic squares (Pherū, 2009). Thus, his innovative ideas to popularise science have worked well even in the science of mathematics. In the words of a modern scholar, Thakkura Pherū provided what seems to be the first Indian account of converting dates between the Muslim calendar and its Indian counterparts. He also explored some aspects of the

[9] For more details on Thakkura Pheru, see Fazila Shahnawaz, 'Thakkura Pheru: A Genius of the Fourteenth century Northern India', *Ateet- A Journal of History and Archaeology (A Peer Reviewed Journal)*, Vol. VII. No. 1–2, December, 2018.

geometry of Islamic architecture. A recent edition and translation of his work highlights Pherū's role as a mediator in several key respects: bridging the gap between Sanskrit and Islamic traditions of learning, connecting the elite Sanskrit with the popular Apabhraṃśa (vernacular), and serving as a link between science and commerce (Pherū, 2009, p. xiv; Plofker, 2010, p. 8).

### 4.3 Shams Siraj Afif and his *Tarjumāh-i-Barāhi*

*Tarjumāh-i-Barāhi*, a Persian translation of *Brhatsamhita* by Varāhamihira (sixth century CE), a Sanskrit text on Indian astronomy by Shams Siraj Afif at the request of Sultan Firuz Shah Tughlaq. It is an encyclopedic work covering all sorts of subjects, including geography and precious stones, all with a view to their significance in astrology. This text deals extensively with mathematical astronomy, the casting of horoscopes, and prognostics (Rahman, 1982, p. 275).

### 4.4 Firuz Shah and translations

Among the Tughlaqs, Firuz Shah Tughlaq demonstrated a particularly strong interest and aptitude in astronomy, surpassing his predecessors. The accession of Sultan Firuz Shah to the throne of Delhi in 1351 CE marked the beginning of a new era in the advancement of science and learning. Shifting from an expansionist approach, the Sultan embraced a resource conservation and development policy. Consequently, his newly established capital, Firuzabad, near Delhi, emerged as a hub for talented individuals and artisans. Sultan Firuz Shah demonstrated a keen interest in astronomy and astrology, fostering a vibrant intellectual and cultural environment during his reign.

*Sīrat* also mentions the royal library (*kitāb khāna-i-khās*) of Sultan Firuz Shah, which is known for manufacturing and usage of astrolabes and astrological tables for determining the time and direction, compositions of books on various sciences, particularly on astrology and astronomy, and their rules and principles, subtleties, explanations, conditions, and truth. These works were attributed to Sultan Firuz Shah Tughlaq, as compiled in accordance with the auspicious views and opinions of the Sultan himself. These works always remained resplendent with the light of scientific knowledge. There were so many of these works that were beyond computation. From every chapter of these works, something has been extracted from the list and offered through specimens to serve as a manifest guide and convincing proof. Volumes of the books were written in detail, chapter-wise, and with elucidatory explanations compiled on astronomy and astrology. They were available and kept ready in the special royal library of Sultan Firuz. Whosoever required anything to add to his knowledge in astronomy and astrology was allowed to pursue the books so that the veracity of this statement might be implanted in his mind (Rahman, 1982, pp. 425–426).

He commissioned the translation of Sanskrit works on astronomy into Persian, reflecting his commitment to transmitting scientific knowledge across cultural and linguistic boundaries. One of the chapters of *Sīrat-i-Fīrūz Shāhī* is devoted to a range of subjects, including astronomy and the preparation of astral charts. They were composed under Sultan Firuz's direction and kept in the *kitāb khāna-i-khās* (royal library). These included *Dalāil-i-Firūz Shāhi*, a translated version of a book in *Hindavi* (Sanskrit) that the Sultan had picked out from the library housed in the temple of Jwala Mukhi at Kangra (Nagarkot). Izzuddin Khalid Khani translated it. It dealt with the prognostications concerning the falling of rains, the gathering of the clouds, the principles of the eclipses of the sun and the moon, the conjunction of the planets and the factors leading to their movement or circulation from one side of the zodiac to the other, and the influence that they exercised. Primarily, the rules and principles of astronomy are driven by it (Anonymous, 1999a, pp. 20–21, 416–425; Anonymous, 1999b, pp. 303–305). This work, compiled by Abdul Aziz Shams Thanesari, is particularly significant as it sheds light on Sultan Firuz Shah's conviction that celestial bodies profoundly influence the Earth and its inhabitants.[10]

The *Sīrat-i-Fīrūz Shāhī* (Anonymous, 1999a, pp. 400–401) elaborates on works such as *Dalā'il-i-Firūz Shāhī* and *Shikārnāma*, noting that Sultan Firuz Shah had attained remarkable mastery over the science of astronomy and its intricacies. His profound understanding led to the composition and compilation of several specialized works under his direction and dictates, many of which were explicitly named after him and reflected the principles he endorsed. Following established rules and principles, astrolabes were constructed, and manuals detailing their manufacture were compiled. One such work is the *Dalā'il-i-Fīrūz Shāhī*, which Sultan Firuz Shah ordered to be translated from Hindawi into Persian. It addresses various astronomical phenomena, including the causes of rainfall, the formation of clouds, the governing principles of solar and lunar eclipses, the conjunction of planets, and the factors influencing their movement from one zodiac sign to another. It also explores the effects these celestial bodies exert on the terrestrial realm. The text is notable for its detailed exposition of the foundational principles of astronomy, many of which are substantiated

[10] The compiler says that he translated it from Hindvi (Sanskrit) into Persian by the order of the religious-minded Sultan, Abul Muzaffar Firuz Shah so that people might benefit from its perusal. The rare manuscript, wrongly entitled by a later scribe as *Kitāb al- Nujum*, is preserved in Sir Sulaiman collection, Maulana Azad Library, Aligarh, ff. 1b- 185b. See Siddiqui, 'Science and Scientific Instruments', p. 141.

through observational evidence. Another significant work from this period is the *Shikārnāma* of Fath Khan, which discusses the astrological characteristics of the twelve zodiac signs, the attributes of the planets, the triadic grouping of celestial signs, and the qualities associated with the lunar mansions (*manāzil al-qamar*). It provides practical guidance for hunters, including auspicious times for embarking on hunting expeditions, predicting the abundance or scarcity of game based on celestial conditions. These astrological principles are presented in detail at the end of the first chapter, devoted to matters related with hunting. In addition, other texts were compiled and translated under the patronage and direction of Sultan Firuz Shah. The *Dastaha* (not known), for instance, outlines the rules governing planetary conjunctions and the influences such celestial events are believed to exert upon the visible world, particularly in relation to disorder and moral decline, by the will of the Almighty. The *Wuddes* or *Veddes* (not known), also known as *Har Minkhla*, explores mysteries and diverse marvellous things of talismanic nature. The *Sarwālī* (not known) is another work focusing on the zodiacal sign of Scorpio, offering astrological prescriptions related to injunctions concerning women travailing in labour, childbirth, guidance for delivery and methods for aiding in the birth process. All these works reflect the Sultan's deep interest in astronomy, astrology, and their applied knowledge, and they were produced as part of a broader cultural and intellectual projects compiled and translated at the dictates of Sultan Firuz Shah.

### 4.5 Mahendra Suri and his *Yantārāja*

The astrolabe was introduced to India through Arabic astronomy. It is called *asturlab* in Arabic, while its Sanskritized form is *ustaralava*. This versatile metallic instrument, consisting of graduated discs, circles, and a gnomon, allowed users to determine planetary positions, the time of day, and other astronomical measurements, making it a sophisticated precision tool. Short Sanskrit works were composed on the construction and use of astrolabes. Several texts on these astronomical instruments, produced by Jain astronomers during the Sultanate period, are also known. One such work is *Yantrarāja* (meaning "King of Instruments") (Suri, 1936) by Mahendra Suri of Bharuch, Gujarat, the first Sanskrit treatise on the Islamic astrolabe in 1370 CE (based on Arabic sources) at the court of Firuz Shah Tughlaq in Delhi. This work gave the astrolabe its standard Sanskrit name and became one of the most influential introductions of a mathematical instrument during the Sultanate period. *Yantrarāja* is divided into five chapters: the first chapter, *Gaṇita*, deals with the theory of the astrolabe and focuses on the fundamental formula and its numerical table for drawing an astrolabe; longitudes and latitudes of thirty-two fixed stars; equatorial, ecliptic coordinates and gnomon-shadow. Second chapter, *Ghaṭanā*, deals with the general construction of astrolabe. Graduation and drawings are explained in the third chapter *Yantrarachana*. The fourth chapter, *Yantrasodhana*, discusses the examination of the astrolabe with a focus on ascertainment of straightness of a straight line. Whereas the last chapter, *Vichārana*, is dedicated to the methods of the use of an astrolabe (Ohashi, 1997, pp. 211–216).

In the opening verses of his text, Mahendra briefly recounts the circumstances of the transmission, stating that many *āgamas* (treatises) on instruments (*yantrās*) had been written by Western scholars, each shaped by their own intelligence. Mahendra, however, distilled the best elements from these texts into a concise yet complete epitome, using the Purāṇic simile of churning nectar from the ocean (Plofker, 2000, pp. 37–54; Plofker, 2010, p. 8). Although Mahendra does not specifically mention the Islamic sources he used to craft his treatise on constructing and using the astrolabe, it is assumed that these were derived from Arabic or Persian prose works typical of the Islamic mathematical astronomy tradition. However, Mahendra's style deviates from the usual geometric presentation found in Islamic astronomical texts, which often explain the astrolabe's projection of the cosmic sphere onto a plane. Instead, Mahendra presents the rules for calculating the positions of various circles and stars in concise Sanskrit verses. He also describes how to draw them on the astrolabe plates and use the completed instrument to solve practical astronomical problems, such as determining the ascendant for horoscope casting or telling time based on the sun's altitude.

Mahendra's student and commentator, Malayendu Sūri, provided the traditional glosses and worked examples in Sanskrit prose, along with tabulated numerical values. It appears that Mahendra, with Malayendu's assistance, adapted the geometric principles and extensive tables from Islamic works to meet the needs of non-Muslim Indian astronomers. In this sense, *Yantrarāja* stands as a masterpiece of technical manual writing, and unsurprisingly, it became the most widely studied Sanskrit treatise on the astrolabe in the years that followed (Pingree, 1971, pp. 363–364; Ohashi, 1997, p. 211; Plofker, 2010, pp. 8–9). Later in 1540 CE, one more commentary was written by Gopiraja on *Yantrarāja* of Mahendra Suri in the Sanskrit language (Pingree, 1971, p. 173; Ohashi, 1997, p. 211).

## 5 Language, translation, and accessibility

The transmission and development of astronomical knowledge during the Delhi Sultanate were deeply influenced by linguistic plurality and translation movements, which facilitated the accessibility of science across religious, cultural, and intellectual boundaries. Sanskrit, Prakrit, and Persian,

each serving distinct but overlapping linguistic communities, played vital roles in both preserving earlier traditions and enabling new scientific syntheses.

### 5.1 Role of Sanskrit, Prakrit, and Persian

Sanskrit, long the language of elite Hindu scholarly traditions, continued to be the medium for high-level treatises on astronomy and mathematics. Despite the growing influence of Persian as the official and courtly language, Sanskrit retained its prestige in Brahmanical, Jain, and scholarly contexts. The *Yantrarāja* of Mahendra Sūri, written in classical Sanskrit in 1370 CE, illustrates the continued vitality of the language in transmitting technical knowledge, especially among non-Muslim scholars affiliated with the Sultanate court (Sarma, 1999, pp. 147–148).

Prakrit, the vernacular derivative of Sanskrit, served as a bridge language for the wider dissemination of scientific knowledge. Thakkura Pherū's *Jyotisāra* and *Ganitasārakaumudi*, both composed in Prakrit were intended for a broader audience, including merchants, scribes, and artisans (Pherū, 1984; Sarma, 1986). These texts consciously departed from the exclusivity of Sanskritic scholarship and used a more accessible register, enabling a wider social segment to engage with astronomy and arithmetic. In this way, Prakrit functioned not merely as a spoken dialect but as a vehicle for scientific democratisation.

Persian, introduced and institutionalised with the establishment of the Delhi Sultanate, emerged as the principal language of administration, historiography, and increasingly, scientific discourse. Its adoption as the medium for *zijāt* (astronomical) texts and translations during the Sultanate of Delhi enabled the cross-cultural exchange of Greco-Arabic and Indian knowledge systems. The courtly use of Persian fostered the integration of Muslim and Hindu scholars in shared intellectual pursuits (Ansari, 2015, pp. 575–601).

### 5.2 Knowledge diffusion through translations

One of the most significant outcomes of this multilingual environment was the translation of key scientific texts, which acted as conduits for cultural exchange and epistemological blending. A notable example is the Persian translation of Varāhamihira's *Bṛhatsaṃhitā*, titled *Tarjumāh-i-Barāhi*, undertaken by Shams Sirāj Afīf at the behest of Sultan Firuz Shah Tughlaq (Rahman, 1982, p. 275). This encyclopaedic work, originally in Sanskrit and dealing with astrology, astronomy, geography, and meteorology, was thus made accessible to a new audience of Persian-speaking scholars, administrators, and courtiers.

Moreover, Firuz Shah's active encouragement of translations from Hindavi (Sanskrit) into Persian exemplifies the Delhi Sultanate's commitment to cultural synthesis. The *Dalāʾil-i-Fīrūz Shāhī*, another translated text attributed to his reign, focused on astronomical phenomena such as eclipses, planetary conjunctions, and rainfall prediction (Anonymous, 1999a, pp. 400–401). These translations were not mechanical reproductions but often involved interpretative adaptations suited to Islamic cosmological and scientific paradigms.

Through these translation efforts, Sanskritic knowledge was integrated into the Islamicate scholarly world, while Persian emerged as a lingua franca of science across religious lines. The movement of ideas across languages not only enriched the intellectual life of the Sultanate but also ensured the preservation and transformation of classical Indian astronomy within a broader Indo-Islamic framework.

## 6 Conclusion

To conclude, the study of astronomy under the Delhi Sultans reveals not merely a phase of passive reception but one of active assimilation, transmission, and transformation. The Islamic scientific tradition was not superimposed upon the newly established Delhi Sultanate; rather, it was integrated, reinterpreted, and transformed with existing indigenous traditions to produce a unique and dynamic Indo-Islamic astronomical culture. The result was a well-developed Indo-Islamic astronomical culture that employed Greek, Arabic, Persian, and Pre-Sultanate Indian elements in a shared intellectual pursuit where observation, calculation, and cosmological speculation found new meanings. Delhi became a prominent center for astronomical studies, cross-cultural scholarly activity, and provided institutional support for scientific advancements. The production of *zīj* literature, translations of Sanskrit and Arabic texts into Persian and vernacular languages and the use of astronomical instruments illustrated the inventive adaptation of inherited scientific traditions during the Delhi Sultanate period. A wide range of contributors, ranging from court poets to mathematician-assayers and royal patrons, exemplify the convergence of literary, mathematical, and astronomical knowledge. Their contributions illustrate how astronomy was not only pursued as a scientific discipline but was embedded in the daily life, culture, religion, and politics of the Delhi Sultanate. The Delhi Sultans, in their intellectual pursuits and cultural policies, created an environment where astronomy and astrology were studied, taught, and applied with remarkable depth and continuity. The legacy of this period lies in its capacity to act as a bridge, linking Indian and Islamic scientific traditions and paving the way for further developments under subsequent regimes. In the larger history of science in the subcontinent, the Delhi Sultanate occupies a pivotal position as a period of intellectual vigor, cultural synthesis, and scientific innovation because of the fertile environment created

by the Sultans of Delhi and their ruling elites for intellectual exchange and the advancement of sciences, particularly of astronomy and astrology.

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